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A NOTE ON THE MIGRATION OF DIVIDES.¹

SAN CLEMENTE ISLAND, one of a group lying off the southern coast of California, is a typical orogenic block,² formed by faulting in geologically recent times. Its drainage is still in its infancy, and is therefore very simple. A study of the topographical features of this isolated mass has led the writer to consider the effect on a previously established drainage system, of faulting with consequent migration of divides.

In the case of San Clemente, as the slope toward the line of faulting is by far the steeper, erosion on that side is much more rapid, and consequently the main watershed of the unmodified crust-block migrates away from that side toward the other. In this case then, the movement of the divide is from the line along which the elevation takes place—that is, from the line of faulting. This differs from an uplift along an axis, without faulting, in a topographically simple region of homogeneous rocks, as in the latter case the axis of uplift itself forms the ultimate divide, while in the former case the resulting divide is situated at some distance to one side of the line of faulting. Thus the effect on a simple drainage system already established will be different for the two kinds of crustal movements, and the law for the migration of divides as given by Campbell³ must be modified in order to make it applicable to an uplift accompanied by pronounced faulting.

This may be illustrated as follows, assuming, as Campbell has done, the simplest possible conditions, in order to eliminate disturbing elements from the problem: In Figs. 1, 2 and 3, C represents the divide between the symmetrical drainage slopes

¹ Published by permission of the Director of the United States Geological Survey.

² Bull. Dept. Geol. Univ. Cal., Vol. I, No. 4, p. 129.

³ Jour. Geol. Vol. IV, No. 5, July-August 1896, p. 580.

of the two stream profiles, C B A and C D E. If faulting occurs parallel to this divide, with a downthrow toward the left, it may occur on either side of C (leaving out of the question the possible occurrence of a fault at C itself). Suppose, first, that the fault is to the left of C, at B (Fig. 1), and that the

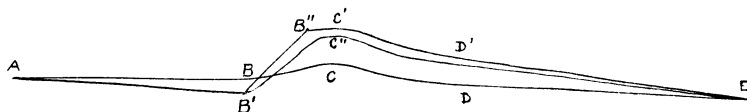


FIG. 1.

faulted portions have assumed the positions indicated by B'' C' D' E and A B', A and E representing the limits of movement in either direction.¹ The part B C will have had its angle of slope decreased by elevation, and therefore the rate of erosion on this slope will be diminished. The angle of the slope C D E, however, will have been increased, and its rate of erosion will be correspondingly greater. The slope C' D' E, then, will be cut away more rapidly than the opposite slope, C' B'', and the divide, C', will migrate toward B'', in accordance with the normal operation of the law. This condition, however, will last only a comparatively short time, for on account of the high angle of B B'' erosion on this slope will be very vigorous, and the point B'' will be rapidly carried back toward C', till the two meet. When this stage is reached the edge of the faulted block will be represented by C'', and the profile, approximately, by B' C'' E. Further erosion will tend to carry the crest C'' toward E, owing to the more rapid cutting on the steeper slope, B' C''. The final result will be that the point C'' is carried to some point such as D', the exact position of which depends on the relative attitude of the points which correspond to B' and E, when erosion has reached this stage.

The second case (Fig. 2), when the faulting is between the

¹ These sections are diagrammatic, and do not attempt to give the exact relative positions of the two parts, as these positions depend on the circumstances obtaining at the time of faulting.

divide, C, and the point E, is similar to the last in the movement of the crest of the faulted block toward D, or away from the line of faulting. In the former case, however, the initial movement (for the fault-block) was toward the fault-line, while in this case that feature is eliminated, as the faulted portion D'' E excludes

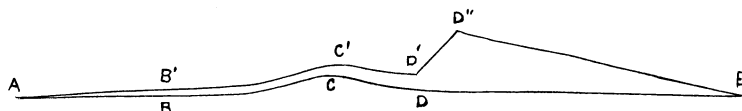


FIG. 2.

the original divide C. In this second case, this movement of the crest of the block D' D'' E is thus away from the divide, C, also, and the final result of the uplift is the establishment of a divide for the crust-block, at some point between D' and E, depending on the relative attitude of these two points.

If the faulting has been sufficient this resultant divide will form the main watershed for the region, the original divide, C being now of insignificant proportions. The faulting may, however, be such that the portion A B C D cannot be left out of account. If, as shown in Fig. 2, the final position of A B C D is more elevated than its original position, the slope CD will have been decreased, while A B C will have been slightly increased. As a consequence there will be a migration of C' toward D'. If the faulting is sufficient in amount, the migrating crest will finally reach D', and there will be no divide other than that of the faulted block, D' D'' E. As the movement of the crest-line in this case is toward E for the parts on both sides of the fault-line, the resultant crest must be at some point between C' and E, whether the amount of faulting be great or small.

If, on the other hand, the movement of A B C D is one of depression (Fig. 3), the result is more complicated, and the final position of the crest C' will depend on the relative attitudes of the faulted portions A B' C' D' and D' D'' E. In other words, if the sum total of movement in the two parts produces elevation, the migration of the divide will be in the direction of E,

while if the resultant of the movement is a depression the divide will migrate toward A.

If the faulted block D' D'' E were elevated from submarine depths to a position similar to that of San Clemente, the final

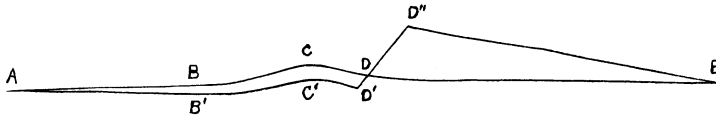


FIG. 3.

result of erosion would be a divide midway between the limiting waters on the two sides.

The results here arrived at must be true in all cases, whether the movements causing faulting are slow or rapid, continuous or intermittent in their action, and small or great in amount. Variation in these factors, however, will cause a variation in the rate of the migration, or in its extent. Other modifying factors are the relative positions of the divide and the line of faulting, and the dip of the fault-plane.

To sum up: Where simple crustal movements occur, causing faulting with resultant elevation, a migration of the stream divide will follow, in the direction of the line of faulting when the fault-scarp faces the divide, away from the line of faulting when it does not. Or, in other words, the migration is from the axis of faulting when the faulted block includes the divide, and toward the axis of faulting when it does not.

WM. SIDNEY TANGIER SMITH.